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Art. IX.—*Geology of the Proposed Nillahcootie Water Conservation Area.*

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(With Plate XIII.).

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I.—Introduction.

Every dry season the Broken Creek, a branch of the Broken River flowing into the Murray, ceases to run, and the result is a water famine over most of the country lying between the Murray and the Broken River. The inlet of Broken Creek from the main river had gradually been silted up, and only flood waters found their way from the river into the creek. Matters were considerably improved by the building of Casey's Weir, just below the point where the flood bed of the creek left the river, and by the cutting of a channel to allow more water to enter Broken Creek. In time of extreme drought the Broken River itself ceases to flow, and consequently even in moderate seasons little or no water finds its way into Broken Creek during the summer months. It was therefore proposed to build a large weir on the Broken River at Nillahcootie, half way between Mansfield and Benalla, in order to conserve sufficient water to keep the Broken Creek continually flowing, even in the dryest seasons, and to supply water for irrigation purposes. A site for a weir was selected just above the junction of Back Creek and the Broken River, and bores and shafts put down in order to test the nature of the underlying rock. The river at this point flows along a gorge about fifty feet deep, cut through solid granite, so that the foundations for the main concrete wall would be perfect.

The proposal was to build a weir about 100 feet in height, and this meant that an embankment over half a mile in length must be built along a neck of land lying between Back Creek and an alluvial flat on the main river. The borings and shafts along this line showed that in places bedrock was not met with till a depth of over seventy feet had been reached, the material passed through being a conglomerate consisting of pebbles set in fine clay, with some gravel in parts, and the conclusion arrived at was that the river had formerly flowed where this bank now stands, and it was considered that the soakage through the river gravels from the reservoir into Back Creek would cause so great a loss of water that the amount conserved would not be sufficient to repay the large initial expense, and further considerable doubt was expressed as to the strength of this ridge, and it was feared that the soakage through this bank might cause a break-away, with disastrous results to the inhabitants of the country lower down the river.

Nothing further was done in the matter until in 1907 the Benalla Water Trust again brought it under the notice of the Minister for Water Supply, who visited the locality and had a fresh report prepared.

I visited the locality with Mr. S. Jeffrey, the Shire Engineer for Benalla, and found that the conglomerate referred to above was of considerable area, and had many of the characteristics of a glacial deposit. Unfortunately the exposures are poor, and it is difficult to determine absolutely whether this deposit is of glacial origin or not; but there is sufficient evidence to show that it would be a great mistake to condemn the scheme until the origin of the conglomerate has been fully worked out. A fresh shaft should be sunk, and the material examined critically by a geologist.

II.—Physiography of the Area.

The valley of the Broken River about Nillahcootie forms the division line between the Strathbogie Ranges and the Mount Samaria and Tolmie Highlands. At the proposed weir site the valley is fairly narrow, and the river bed is gorge-like, but higher up wide open alluvial flats exist, forming a splendid storage area for immense quantities of water.

A few miles below the proposed weir site the valley commences to widen out, and the river flows on through Benalla, over open alluvial plains, and joins the Goulburn at Shepparton. About six miles below Benalla the Broken Creek leaves the main river and runs in a north-westerly and westerly direction to join the Murray.

At Gowangardi the Broken River flows between low hills of silurian sediments, and there is little doubt that this part of its course is of comparatively recent origin, and that Broken Creek was formerly the main stream, the gradual building up of which led to the formation of a newer and shorter course to the Goulburn.

The source of the main stream is in the hills to the north of Mansfield, and it is soon joined in the Parish of Dueran by Bridge Creek and Blue Range Creek, which rise in the Tolmie Highlands, and Thomson's Creek, which rises in the hills to the south. Just at the northern boundary of the Parish of Nillahcootie the river is joined on the west by Sandy Creek, whose source is in the eastern portion of the Strathbogies. About a mile further north Back Creek, with its tributary, Wild Dog Creek, enter the river from the east.

To the west of the river valley at Nillahcootie lies the somewhat dissected pene-plain of the Strathbogie. The general level of this area ranges from a thousand to fifteen hundred feet above sea level, but here and there hills like Mt. Separation and Mt. Barrenhet stand well up above the surrounding country.

On the eastern side the country is more rugged, the ascent from the river being rapid, and in some places precipitous, falls 150ft. high being found on both Back Creek and Wild Dog Creek. The highest point in this neighbourhood is Mt. Samaria, which rises to a height of 3138ft. above sea leved. On the slopes of Mt. Samaria some good grassy flats are met with, but south and east from this point the country is extremely rough, very heavily timbered, and rendered almost impassable by the dense growth of wattle and other scrub. Other prominent hills on the eastern side of the river are Hat Hill and Mt. Wombat. The country above the proposed weir site is fairly open, as the river here flows through undulating country composed of Carboniferous sandstone, and is only separated on the south from the basin of the Goulburn River by a low ridge of similar rocks.

III.—THE GEOLOGICAL SEQUENCE.

The rocks of this area may be divided into four groups. (A) A series of sedimentary rocks showing considerable contact metamorphism and probably of Silurian age. (B) Igneous rocks of acid to sub-acid composition intruded into the silurian series and Devonian in age. (C) Conglomerates occupying portions of the valleys of Wild Dog Creek, Back Creek, and the Broken River, probably of glacial origin, and of uncertain age. (D) Recent alluvial deposits along the course of the streams.

(A).—*The Silurian Rocks.*

The sedimentary series consist of indurated mudstones, shales, slates, quartzites, hornfels, etc., the alteration being due to the intrusion of the granites and porphyries. The strike of the rocks is very irregular, but still seems to have a general northerly direction. So far no fossils have been found in these beds, but there is little doubt that they are silurian in age, as they occur on the same line as the fossiliferous sandstones of silurian age occurring at the Reef Hills, Benalla, and the silurian limestones of Loyola, near Mansfield.

Acid apophyses from the granite are to be seen intrusive into the sediments near the contact. The strata are much jointed and faulted, and show considerable contact metamorphism, most of the rocks showing the presence of mica and other secondary minerals. In the bed of Back Creek, about two and a-half miles above its junction with the Broken River, a sharp junction between the sedimentary and igneous rocks is seen, and sections show that the contact rock is a typical hornfels consisting of granular quartz, with a considerable amount of biotite.

(B).—*The Igneous Rocks.*

Three distinct types of acid igneous rocks occur, which may be provisionally called granite, granite porphyry and quartz porphyry.

The granite is only found at the lower levels along the river bed at about 800ft. above sea level. On the eastern side of the river silurian rocks containing acid veins are met with at about 850ft., and climbing upwards along the surveyed road to Mt. Samaria, these rocks are traversed until a height of 1100ft. is reached, when granite porphyry makes its appearance. The road passes along over this till, at a height of 1500ft., the Silurian rocks reappear, but at 2400ft. they give place to a granite porphyry having a groundmass distinctly finer than the previous occurrence, and the porphyritic felspars are much smaller. On the final slope leading to Mt. Samaria, the prevailing rocks are silurian sediments, but the denudation of these frequently exposes the underlying porphyry, now passing to the quartz porphyry type. Finally at a height of 3138ft. above sea level the summit of Mt. Samaria is found to consist entirely of a quartz porphyry showing phenocrysts of quartz and felspar in a fine-grained groundmass. The northern face of the mount is extremely precipitous, and an imperfect columnar jointing in the porphyry is to be observed. Extending in a north-easterly direction from this point lies the main mass of the porphyry forming the Toombullup and Tolmie Highlands.

On the western side of the river the granite rises to some hundreds of feet above the level of the river. Porphyry occurs also on the Strathbogie side, but this area has not been examined, so that the junction of the two types is not known.

(C).—*The Conglomerate.*

The best development of the conglomerate is met with below the junction of Back Creek and the Broken River, where it reaches a width of 50 chains and is up to 70ft. in thickness. The conglomerate consists of boulders and pebbles of all sizes, set in a fine graned material, the boulders consisting of quartzite, hornfels, indurated mudstone, shales, quartz, granite, granite porphyry, aplite, tourmaline aplite, quartz porphyry, etc. The general size of the boulders is from 1ft. down to an inch or two in diameter, the largest noted being in a small road cutting near Back Creek, where a boulder of granite porphyry over 4ft. long occurs alongside a mass of indurated mudstone about 3ft. in length. Many of the boulders are facetted and polished, but striated boulders are rare, the few that were found not being entirely satisfactory, so that the determination of the conglomerate as of glacial origin at present rests rather on its mode of occurrence, distribution, form of pebbles, etc., than on the presence of striated boulders.

Very few sections through the conglomerate are met with, the bulk of the material lying in a valley between the present river bed and the hills to the east, and the thickness is only known from the depth of bores and shafts put down along the line originally proposed for the weir site. Unfortunately the shafts have been filled in, so that no information can be obtained in them.

The general distribution of the conglomerate is shown in the accompanying sketch map of the area. The upper portion lies near the base of a steep scarp to the south of Mt. Samaria, and it becomes almost impossible to trace it on account of the fallen material from the scarp in places completely covering the surface. It is in this part, however, that the best section occurs, a small cross valley exposing a thickness of 40ft. of conglomerate. The pebbles are mostly small, being between 2 and 4 inches in diameter, larger ones being rare. Most of the pebbles show facetting, and are all smooth and polished, but no striations were observed. The pebbles consist almost entirely of hard quartzite, and are set in a fine-grained matrix. In general the whole mass is firmly cemented together, and large blocks of conglomerate are found along the bed of the cross valley. At this point the upper part of the conglomerate is about 100ft. above the level of Wild Dog Creek.

Along the Broken River, above its junction with Back Creek, abundant boulders and pebbles occur in the bed of the river, and although now waterworn and showing no signs of facetting, they quite possibly represent resorted glacial material, especially as many of the boulders consist of a dyke rock composed of a soda hornblende, and an alkali felspar, which must have travelled a considerable distance, as no outcrop of such a rock occurs along the stream for many miles above Dawes' Flats, where boulders of it are extremely common.

Along the sides of the valley and well above present flood level, are found pebbles of quartzite resting on the granites, and the form of these pebbles suggests a glacial origin. So far I have had no opportunity of examining the country higher up the valley, where possibly more conglomerate would be found.

Below the junction of Back Creek with the Broken River the conglomerate widens out, and can be traced some distance down the stream, but finally gives place to alluvium and resorted boulders from the conglomerate. About a mile and a-half below the junction a narrow belt of conglomerate joins the main mass on the east. This tributary portion is considerably dissected, but the whole surface of the ground is covered with ferns and scrub, so that very little can be seen of the nature of the material.

The evidence in favour of this conglomerate being of glacial origin is as follows:—

(1) Many of the boulders are facetted, smoothed and polished, and are generally quite unlike water-worn material. Here and there blocks are seen having a portion of its surface smoothed, but the remainder is rough and angular.

(2) The composition of the boulders found in the conglomerate is of an extremely varied character, and although most of them can be matched with the rocks in the district, some are quite distinct from any known rocks in this vicinity, and have probably travelled a considerable distance from the place from which they were derived.

(3) The composition of the boulders seems to bear no relation to the composition of the underlying rock, i.e., a change in the composition of the underlying rock causes no change in the relative proportions of the various types of rocks contained in the conglomerate.

(4) The matrix seems to vary with the composition of the underlying rock, being fine grained and seemingly composed of ground-up sedimentary rocks, where the conglomerate rests on the silurian. Whereas angular quartz is fairly abundant throughout the matrix, where the bedrock consists of granite.

(5) Microscopic sections of the matrix show that the constituent grains are angular to subangular, and so are distinct from rounded water-worn grains.

(6) The distribution of the conglomerate, especially below the junction of Back Creek and the Broken River, where it is over half a mile in width, and about 70ft. in thickness, can be easily explained if we accept the glacial origin of the conglomerate. If the conglomerate be not due to glacial action, then it must be of river formation. From the site originally proposed for the

weir, for some miles down stream the fall of the river is fairly rapid, and there is no apparent cause why the stream should build up its bed over 70ft., and then set to work to carve out a new channel for itself in the granite.

The absence of typical striated boulders is, of course, a strong argument against the glacial origin of the conglomerates, but this absence may be partially explained by the fact that the bulk of the pebbles are composed of quartzite, granite and porphyry. The first named being extremely hard, may have resisted scratching, and only show polishing, and the decomposition of the surface of the igneous rocks would remove all traces of striations, if such had ever been present.

(D).—*Alluvium.*

The distribution of the alluvium is shown in the accompanying map. In part this is rich river wash, but the lower level material is composed mainly of resorted material from the conglomerate with only a small proportion of finer material.

IV.—PETROGRAPHY.

The igneous rocks of this area may be divided for the time being into granite, granite porphyry and quartz porphyry, the discussion as to their correct nomenclature being reserved until later. Aplitic and pegmatitic veins are associated with the granite.

(A).—*Granite.*

The granites are only found to occur at the lower levels along the valley of the Broken River. The colour of most of the rock is red, this colour being secondary and due to the alteration of the felspars and ferro-magnesian minerals.

The structure of the rock is peculiar, as it has a porphyritic appearance, due to the fact that large blebs of quartz and felspar crystals are set in a granular mixture of quartz and felspar, with here and there a granophyric intergrowth of quartz and felspar. Cross sections of the large quartz grains show a rough hexagonal outline, and the large felspars show fairly perfect crystal boundaries. Flakes of white mica with a pearly lustre are present, and biotite showing considerable alteration is moderately abundant.

Under the microscope the rock is seen to consist of quartz, orthoclase, plagioclase, biotite and muscovite, with minor accessories, such as apatite and magnetite in very small amount. The quartz is clear and colourless, although in parts it is slightly clouded by the numerous bubbles scattered irregularly through it. The larger grains show numerous cracks. Both orthoclase and plagioclase are present, the latter being slightly the more abundant. The orthoclase is very much decomposed, the alteration products being mainly kaolin and secondary mica. Carlsbad twins are fairly common. The orthoclase shows a considerable amount of microperthitic intergrowth, and patches of almost fresh secondary plagioclase occur in the orthoclase. The extinction angles of these secondary felspars show that they are albite. The plagioclase is also very much altered, and the decomposition products in this case are kaolin, secondary mica and zoisite. Many of the felspars are so much decomposed that it is impossible to read the angles of extinction, but one which was much fresher than the remainder gave angles conforming to andesine having the composition $Ab_4.An_3$. This particular crystal is of great interest, as it not only shows twinning according to the carlsbad and albite law, but also according to the maneback and possibly the pericline law. The centre of the mineral has been replaced by a secondary felspar which is quite fresh and shows traces of albite twinning. The ref. index of the secondary felspar is shown by Becke's method to be higher than that of the original mineral, and so belongs to the basic end of the plagioclases. A few of the plagioclases show traces of zoning, but the range of difference in composition is very slight. The muscovite is fresh and occurs in irregular flakes, showing high polarization colours. The biotite is bleached and partially converted to chlorite, with the separation out of iron oxide along the cleavage flakes. Under the microscope the character of the intergrowth of the quartz and felspar is well seen. In part this intergrowth is of a granophyric type, and in part it seems to consist of rounded blebs of quartz set in a large felspar crystal.

(B).—*The Granite Porphyry.*

The granite porphyry has a considerable range in texture, merging in one direction into a porphyritic granite, and in the other into a quartz porphyry. The hand specimens show that the rock is light grey in colour, and consists of phenocrysts of felspar, with some quartz set in a finer grained ground mass, a comparison of the various types showing that as the groundmass becomes finer in grain, the phenocrysts decrease in size.

Under the microscope the rock is seen to consist of idiomorphic plagioclase phenocrysts, with occasional irregular grains of quartz, set in a hypidiomorphic to granular groundmass of of quartz, plagioclase, orthoclase, with numerous flakes of mica. The felspar phenocrysts in general show good crystallographic boundaries, but some are considerably corroded. A measurement of the extinction angles of one of the phenocrysts, which shows both carlsbad and albite twinning, proved that it was andesine of the composition $Ab_4.An_3$, and therefore similar in composition to the plagioclases of the granite. A second section which showed good zoning gave extinction angles, proving that the central area was an acid andesine, and that the composition ranged from this to an acid oligoclase on the margin.

The groundmass consists of quartz felspar and mica. The quartz, which is clear and colourless, occurs in rounded grains, in which are to be seen bubbles and included needles of apatite. The felspar in the groundmass seems to be mainly plagioclase, but some sections showing an entire absence of twinning are probably orthoclase. By the use of Becke's method the refractive index of the felspars is seen to be generally about the same, or lower than that of quartz, and higher than that of the canada-balsam, so that the felspars are either andesine or oligoclase. Biotite is abundant, some being quite fresh, brown in colour, and showing intense pleochroism, the remainder being more or less converted to green chlorite. Included in the biotite are small crystals of apatite and magnetite, surrounded by pleochroic halos. Magnetite has also separated out along the joint planes in the chloritized mica.

(C).—*The Quartz-porphyry.*

The quartz porphyries are light grey to dark blue grey in colour, and show phenocrysts of quartz and felspar with occasional flakes of mica in a fine grained groundmass. A section from the foot of Wild Dog Creek Falls shows rounded and corroded crystals of quartz, with numerous corroded felspars set in a micro-crystalline groundmass. The felspars are very much altered, some being so much so that it is impossible to determine even whether they are orthoclase or plagioclase. One of the less altered phenocrysts is andesine approximating to the composition $Ab_1.An_1$. Orthoclase is almost certainly present, as some of the kaolinized felspars, showing not the slightest trace of twinning, contain a micro-perthitic intergrowth of a fresher felspar, which is probably albite. Flakes of biotite are not uncommon, some being fairly fresh, while others are partially or completely altered to a strongly pleochroic chlorite, which gives a change from a brownish green to a light whitish green. Inclusions of apatite and magnetite are fairly abundant. The groundmass is granular and consists of quartz and felspar with minute flakes of chloritized mica. Using Becke's method the felspar is found to have a refractive index lower than that of quartz, and different sections show refractive indices greater, equal to, and less than that of canada-balsam, so that we evidently have orthoclase and an acid plagioclase both present.

A section cut from a specimen obtained from the summit of Mount Samaria, alongside the Trig. station, shows somewhat similar character, but is much finer in the grain. The groundmass is felsitic, and consists of quartz and felspar, with minute flakes of mica. The felspar microlites are too small to determine. Quartz intensely corroded and embayed, and both orthoclase and plagioclase occur as phenocrysts. Flakes of mica are fairly abundant, and garnet, surrounded by a ring of chloritized mica, is present.

(D).—*The Nomenclature of the Rocks.*

Most of the more acid plutonic rocks of Victoria come under the head of grano-diorite, as they have basic felspar in excess of the alkali felspar. In the rock described in this paper the orthoclase is about as plentiful as the plagioclase, and moreover the plagioclase in this case is andesine and not labradorite, the common felspar of grano-diorite. Biotite is not nearly as abundant in this rock as in the grano-diorites of Harcourt and elsewhere.

The name granitite, using it in the English sense as being a granite having approximately equal amounts of orthoclase and plagioclase, fits the description of this rock exceedingly well, the only objection to the name being that it has been used in more than one sense, and its use therefore is likely to lead to confusion.

Harker does not use the term granitite at all, such rocks as the above being included under the heading of granite. Kemp and Merrill also seem to have dropped the term, while Rosenbusch uses it as meaning a biotite granite, that is, one containing no muscovite. All things considered, therefore, the name granite seems to be the most suitable for this rock.

Neither the granite porphyry nor the quartz porphyry conforms to the description of the normal types, as both should contain orthoclase in excess of plagioclase, whereas the bulk of the felspar in both cases, especially the phenocrysts, belongs to the soda-lime series of the plagioclases. Harker divides those intrusive rocks in which quartz phenocrysts are typically absent into porphyry and porphyrite according as the dominant porphyritic constituent is an alkali felspar, or a soda-lime felspar. Extending this definition to cover the quartz rich rocks, we would get granite-porphyrite, and quartz porphyrite as the names for the rocks described in this paper. In the absence of a chemical analysis, however, it is very difficult to estimate the relative proportions of the alkalis to the lime, especially as the groundmass is fairly fine grained, so that pending such analyses the names granite porphyry and quartz porphyry had better be retained. Furthermore, the igneous rocks of this area are distinctly more acid than the main mass of the Strathbogie and Toombullup Ranges, and seem to represent an acid differentiation from a grano-dioritic magma, and the name quartz-porphyrite would be more suitably applied to some of the less acid members of the series, the rocks of this area being an intermediate type between these and the normal quartz-porphyry.

V.—Age and Relations of the Rocks.

The oldest rocks in this area are the sedimentary series which have been shown to be probably of silurian age. During the deposition of these beds, land surface existed a few miles to the east, as we find a series of shore-line conglomerates occurring along the eastern flank of the Tatong Hills and continuous with these we get the silurian conglomerates which overlie the phosphate beds at Mansfield. The sedimentary series have been much folded and contorted, and have been intruded by the granites and allied rocks. This intrusion is clearly proved by the well-marked contact metamorphism exhibited in the sedimentary rocks near the junction of the two series. The presence of acid veins from the granite intruded into the silurian rocks, gives further evidence as to the relation of the granite to the sedimentary rocks.

This fixes the age of the granites and porphyries as post-silurian, that is if the silurian age of the sediments be accepted. There is no necessity, however, to depend solely on the contact in this area, as the rocks of the Strathbogies certainly belong to the same series, and there is no doubt that they are intruded into the silurian, as contact metamorphism is very marked all along the southern boundary of the Strathbogie massif. The southern extension of the porphyries forming the Toombullup and Tolmie Ranges is covered by sandstones of lower carboniferous age, and there is no sign of contact alteration in these sandstones, so that the porphyries are undoubtedly pre-carboniferous, and consequently belong to some part of the devonian.

The lower devonian was a time of intense earth movement in Victoria, and these earth movements were accompanied by intrusions of igneous rocks, so that there is little doubt that the granites, granite porphyries and quartz porphyries of this area belong to the lower devonian.

The relation of the igneous rocks to one another is exceedingly interesting. The mineral composition of the various types of igneous rocks in the area shows that they have been derived from a common magma, in which very little differentiation has taken place. From Mount Samaria to the Broken River we get an ideal section illustrating the effect of pressure on a consolidating magma, the increase of coarseness of grain of the constituent minerals being to a certain extent proportional to the increase of pressure under which the minerals crystallized. Commencing at Mount Samaria with a quartz porphyry having an exceedingly fine groundmass, we pass to the porphyry at Wild

Dog Creek Falls, having a fairly coarse granular groundmass. From this we pass to a granite porphyry, which in itself shows an increase of coarseness of grain as we descend the hill, and finally to the coarse-grained plutonic granite occurring along the river nearly 2400ft. below the summit of the hill.

In devonian time the highlands were continuous from the Strathbogies across the present valley of the Broken River to the Toombullup Ranges, and this ridge formed the northern boundary of the basin in which the carboniferous sandstones were laid down.

So far I have only examined the carboniferous sandstones sufficiently to show that they are younger than the granites and porphyries which underlie them. The age of the conglomerate is extremely doubtful. They are certainly post-carboniferous as fragments of carboniferous sandstones are present in them. If of alluvial origin they are probably of pliocene age, but if of glacial origin they may go back as far as permo-carboniferous. To the north Mr. A. E. Kitson records several patches of conglomerates of glacial origin at Greta, Taminick and Glenrowan, and suggests that they are possibly permo-carboniferous in age, from their general similarity to the conglomerates of Bacchus Marsh.

Suitability of Area for Water Conservation.

In considering the suitability of the area for water conservation purposes it is necessary to discuss the geological features of the area of the reservoir, the catchment area, and more briefly the area to be served.

The reservoir area is bounded on the east and west mainly by granitic rocks with some silurian sediments on the eastern side. The south and south westward boundaries are composed of carboniferous sandstones. High level alluvium may border portion of the area, but if this were stripped off it would be seen that the proposed reservoir was surrounded on all sides except a narrow outlet to the north by rocks of palaeozoic age. This then should give a basin from which very little soakage could take place, the only parts where slight loss might be expected being along the junctions of the different series and down any fault and joint planes present in the rocks.

The northern boundary of the reservoir would consist of a concrete wall running from the western granite margin across the river bed to the granite at the other side of the bed, and then continued by an embankment resting on portion of the conglomerate beds unless it were found necessary to run the concrete wall right across the northern end of the reservoir. If, as seems probable, this conglomerate is of glacial origin, then there is certainly no necessity to sink through these beds in order to let the foundations of the concrete into bed-rock, as the conglomerate itself would possess quite as good holding powers as the underlying granite and silurian. Should the conglomerate on further investigation be proved to be of glacial origin then the loss by soakage through it might be taken as being nil, and there could be no doubt about the suitability of the area for a weir site.

On the other hand there is the possibility of the conglomerate turning out to be due to river action, and then there would be the chance of a considerable loss by soakage unless the concrete weir was let into the underlying rock. Further, there would be no comparison between the holding strength of such a river deposit, and a conglomerate of glacial origin. The sinking of a single shaft through these beds should settle definitely their origin and give a sure basis on which to estimate the probable cost of the weir.

The catchment area requires very little comment. The whole area is practically surrounded by well-wooded hills, and as the structure of the country is similar to that of the reservoir area there would be little loss of water, because the water which did soak into the ground on the hill sides could find no outlet except into the reservoir. Shut in as it is by hills the loss of water from the reservoir by evaporation would be small. The standard of purity of the water should be high, especially that derived from Back Creek and Sandy Creek, flowing as they do mainly over granitic rocks. The water which comes down the main river in flood time carries a considerable amount of red sediment in suspension derived from the carboniferous rocks, but the water contains very little dissolved matter. The area to be served is part of the Murray Plains, which have apparently been formed by the building up of the whole engrafted Murray

River system consequent on the extension of the length of the river owing to the formation of the coastal plains of South Australia. This being so, it follows that this area was formerly part of an extensive peneplain, the somewhat irregular surface of the country at that time consisting of the older palaeozoic rocks with only a small proportion of alluvium. The building up of the country would be gradual, and the various streams would constantly change their beds, so that bands of sand and gravel should be found in various parts of the alluvial deposits indicating former stream channels. A considerable amount of the reclamation would be due to deposition of fine silt during flood times, so that the general structure of the alluvial deposits would consist of irregularly bedded clayey material, with "horses" of coarser material formed along former main stream courses.

In any channelling which might be required for irrigation purposes it would be necessary to guard against loss through soakage into the sand and gravel beds. If the structure be as indicated, it follows that there would be an unequal distribution of the underground water, as the supply at any place would depend on the surface contour of the old pene-plane, and on the distribution of the sand and gravel beds throughout the finer-grained clayey material. This means that it will not follow that a plentiful supply of water will be found in any part of this area because a good well exists on a neighbouring farm.

It is therefore certain that wells cannot be depended on to give an adequate supply of water over the whole area, and this country must depend on large dams or on a supply derived from some large reservoir.

Summary.

1. The general physiography of the area is described, and it is pointed out that Broken Creek represents the former main course of the Broken River, the present bed of the river from the junction to Shepparton being of comparatively recent origin.

2. The geological sequence of the rocks in the proposed water conservation area is set out, particular attention being directed to beds of conglomerate, the origin of which is to a certain extent in doubt.

ERRATUM.

Plate IX. should be numbered XIII.

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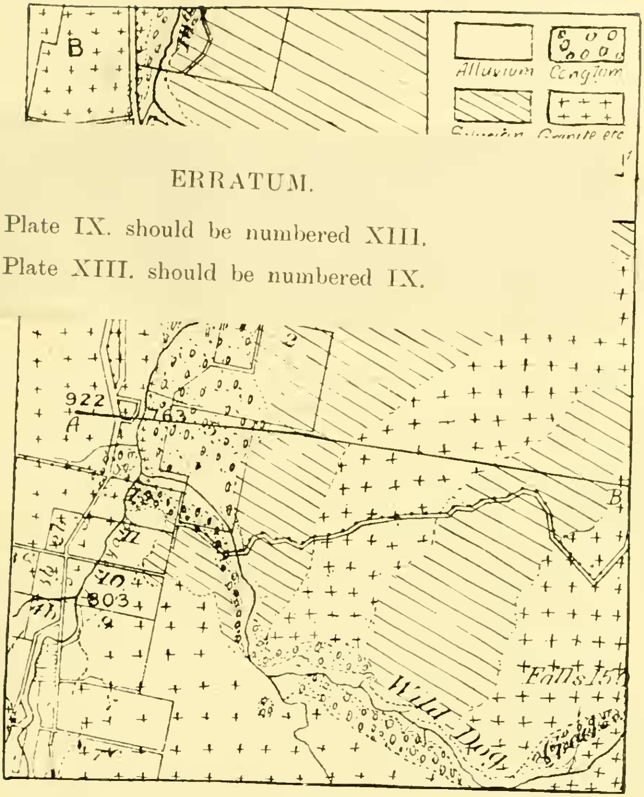

Fig 1

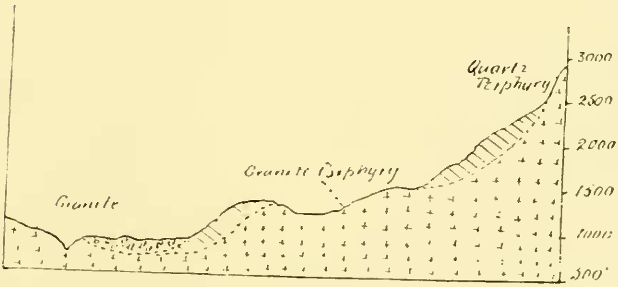

Fig 2